ECONOMICS OF DELINTING COTTONSEED

TO LOW RESIDUAL LINTERS AT OIL MILLS

By Elmer L. Pardue and S. P. Clark

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Joseph G. Knapp, Administrator

The Farmer Cooperative Service conducts research studies and service activities of assistance to farmers in connection with cooperatives engaged in marketing farm products, purchasing farm supplies, and supplying business services. The work of the Service relates to problems of management, organization, policies, merchandising, product quality, costs, efficiency, financing, and membership.

The Service publishes the results of such studies, confers and advises with officials of farmer cooperatives; and works with educational agencies, cooperatives, and others in the dissemination of information relating to cooperative principles and practices.

Contents

Highlights

Management of a cooperative or other cottonseed mill needs to determine its most profitable levels of delinting under varying prices for chemical linters. To help management obtain this objective, this report defines and evaluates factors affecting the sales values and costs of recovering chemical linters and develops procedures by which mill managers can apply their own revenue and cost figures to determine their most profitable levels of delinting.

When mills change their level of delinting, hull revenue and several costs likewise change.

Hull revenue is the most important item affected by changes in delinting level. Linters have sales values whether removed as linters or left on hulls and sold at hull prices. The amount of reduction in hull revenue when linters are removed from hulls depends on hull prices, which vary widely by areas and seasons. Based on seasonal average hull prices received by 12 cooperative oil mills during 1959 through 1963, the portion of cost of delinting as measured by reduced hull revenue would have ranged from 0.3 cent to 1.1 cents a pound of linters.

In addition to reduced hull revenue, the more important costs affected by delinting levels are costs of power used by delinting stands, bagging and ties, and operating labor. Less important costs are those for saws, gummer files, maintenance, and supplies.

The cost of power used by delinting stands depends upon both delinting levels and electric rate schedules. If delinting level were changed from 3 to 2 percent residual linters on seed, the cost of power, as based on electric rate schedules in effect at 15 cooperative mills, would range from 0.15 to 0.51 cent a pound of additional linters. If delinting level were changed from 2 to 1 percent residual linters, power costs would increase further to 0.24 to 0.83 cent a pound of additional linters.

Cost of bagging and ties can be relatively important or minor, depending on purchase price of bagging and ties and sales price of chemical linters. Prices paid for bagging and ties by 10 cooperative mills during the 1960-61 season ranged from $0.89 to $1.90 a pattern. When chemical linters sell for 3 cents a pound and cost of bagging and ties is from $0.89 to $1.90 a pattern, the net cost of bagging and ties is 0.08 to 0.25 cent a pound of linters.

Operating labor may be affected by changes in delinting level, depending on how great a change is made and the degree to which labor is utilized before the change. An example in the report shows that a change in delinting level from 3 to 1 percent at one mill, where labor was fully utilized, required the use of two additional men and increased labor cost by 0.4 cent a pound of additional linters. At another mill, delinting labor was not fully utilized and the same delinting change did not require additional men.

Cost of saws and gummer files appears high in terms of once a season purchase but are relatively small on a per unit cost basis. The cost of saws ranged from only 0.012 to 0.146 cent per pound of linters when blank saws cost 60 cents each; and cost of gummer files ranged from only 0.017 to 0.056 cent per pound of linters when files cost 20 cents each.

Other miscellaneous costs, for which data could not be obtained, include maintenance and supply items such as gasoline and lubrication oil for lift trucks.

Changes in delinting levels can affect chemical linter revenues and therefore the price received as well as costs. Linter saws tend to produce more hull fiber as closer delinting cuts are made. Cleanness and cellulose content of baled linters depend on more than the level of delinting, however. Other things that affect the price received include seed condition such as moisture content and amount of foreign matter, seed cleaning equipment, lint beater capacity, and other factors. Because these vary widely among mills, effects of changes in delinting level on linter quality could not be evaluated separately in this study. When quality of chemical linters is adversely affected, the lower price must be considered as an additional cost of delinting.

When cottonseed is delinted through the first-cut stage and far enough into the second-cut stage for efficient hulling and milling operations, a primary decision for mill operators is how much closer to delint for maximum returns. This decision can be approached by determining the lowest price for chemical linters that will offset the cost of the additional delinting. In this report, such a minimum price is referred to as a "break-even price." This price is equal to the cost of delinting to the lower level, and includes the reduction in hull revenue.

Break-even prices for chemical linters were calculated for two hypothetical mills. One mill was assigned high delinting costs and the other mill low costs. The high-cost mill had delinting costs of 2.7 cents a pound of additional linters when changing from a 3 to 1-percent level of residual lint compared with only 0.8 cent a pound for the low-cost mill. The break-even or minimum chemical linter price in case of the high-cost mill would be 2.7 cents, and a change in delinting level from 3 to 1 percent would be profitable only when chemical linters price is 2.7 cents a pound or above. By contrast, the low-cost mill could profitably change from 3 to 1 percent residual linters when chemical linters price is as low as 0.8 cent a pound.

Economics of Delinting Cottonseed to Low Residual Linters at Oil Mills

By Elmer J. Perdue[1]

and S. P. Clark[2]

This study analyzes factors affecting costs and revenues associated with changes in levels of delinting cottonseed. It will guide mill operators on how close to delint seed under varying prices for chemical linters.

The relationship between delinting costs and sales value of chemical cotton linters is important to cottonseed processors. Under present technology, delinting is one of the costliest operations in cottonseed processing. On the other hand, sales value of chemical linters fluctuates widely, at times being well above--but at other times approaching--the range of direct recovery costs.

Oil mill prices for chemical linters have been consistently low in recent years due to improved quality and increased production of competitive wood-pulp cellulose. In the face of possible chronic low prices for chemical linters, mill management needs to know the costs and revenues associated with delinting seed to varying residual levels.

Most mills sell chemical linters on a cellulose basis. Prices received vary with such quality factors as amount of foreign material and color. Generally, foreign matter will decrease and higher cellulose content will result as fewer linters are removed from seed. That portion of linters not removed will remain on hulls and be sold at hull prices. Recovery of lesser amounts of linters also results in lower costs.

Objectives

The major objectives of this study were: (1) To define and evaluate factors that affect costs and sales values of chemical cotton linters; and (2) to develop procedures whereby mill management can apply their individual cost and revenue data to determine how close to delint cottonseed under varying prices of chemical linters.

Scope and Method of Study

Prices of first-cut or felting linters usually are high enough to insure their production. In addition, most mill operators believe that some delinting beyond the first cut is necessary

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[1] Cotton and Oilseed Branch, Marketing Division, Farmer Cooperative Service, U.S. Department of Agriculture.

[2] Cottonseed Products Research Laboratory, a part of the Cotton Research Committee of Texas, operated by the Texas Engineering Experiment Station, Texas A & M University, College Station, Tex.

for efficient hulling and separating operations. Therefore, this study was limited to costs and revenues associated with recovering linters within the range of 1 to 3 percent residual linters left on the seed. This recovering operation involves the last 20 to 40 pounds of linters per ton of seed crushed.

Only costs that change with changes in percentage of residual linters left on seed were considered. Costs such as investment in machinery, equipment, and buildings are fixed for practical purposes within a given crushing period and will not be affected by changes in yield of linters.

The mill's management needs to make a somewhat broader analysis when it is planning to expand, or to build a new mill. At that time, cost of machines and the portion of buildings associated with the lower levels of delinting would have to be considered. This broader area of analysis was not included in this study.

Delinting costs vary greatly by mill area and to lesser extent among mills within an area. Some of the more important items causing variation in costs are: Hull prices, electric rate schedules, and cotton variety.

Cost information was obtained from records in the files of Farmer Cooperative Service, U.S. Department of Agriculture, articles published in trade journals, and correspondence with management of selected cottonseed mills. Cost data are presented for illustrative purposes only; they do not represent averages or ranges for the industry.

Electric power requirements to operate linter stands[3] at various delinting levels were obtained by the Cottonseed Products Research Laboratory under contract with Farmer Cooperative Service. The remainder of the study was conducted jointly by Farmer Cooperative Service and the Cottonseed Products Laboratory. It is operated by the Texas Engineering Experiment Station, Texas A&M University, College Station.

Costs

Many cost items are involved in production of chemical linters at oil mills. Some of the more significant direct or variable costs are reduced hull revenue, power for linter stands, operating labor, and bagging and ties. Less important costs are saws, gummer files, maintenance, and operating supplies.

Reduced Hull Revenue

At most mills, hull revenue is the most important single item affected by changes in levels of delinting. Linters have sales values whether removed and sold as baled linters or left on delinted seed and sold as hulls.

Linters removed from seed reduce hull revenue by an amount equivalent to the number of pounds of such linters multiplied by the price of hulls. For example, a change in delinting level from 3 to 2 percent simultaneously increases yield of linters and decreases yield of hulls around 20 pounds per ton of seed. If the price of hulls were $20.00 a ton (1 cent a pound), hull revenue would be reduced by 20 cents. Therefore, the cost of the additional 20 pounds of linters in terms of reduced hull revenue is 1 cent a pound

Hull prices vary widely among cooperative mills and their seasons, as shown in table 1. The greatest spread was in 1959-60 when Mill 6 received $16.75 per ton and Mill 3 received $6.08. Reduction in hull revenue based on this spread is from 0.3 to 0.8 cent per pound of linters. When all years are considered, the spread increases from $6.08

[3] Technically, the machine used to delint cottonseed is called a linter and the fiber is called linters. To avoid confusion in use of these similar terms the machine used for delinting is referred to as a linter stand in this report.

Table 1.--Average prices per ton received for hulls: 12 cooperative cottonseed oil mills, crushing seasons, 1958-63

Mill No.	1958-59	1959-60	1960-61	1961-62	1962-63
1	$8.85	$ 7.65	$11.35	$9.62	$14.06
2	6.20	7.45	11.96	9.53	14.22
3	8.12	6.08	12.78	9.08	14.33
4	10.64	8.75	13.08	10.45	16.77
5	10.79	9.55	13.42	12.36	16.23
6	14.61	16.75	16.32	12.26	12.34
7	9.12	7.60	13.04	9.61	15.15
8	12.45	16.10	18.04	14.58	19.45
9	11.70	13.77	20.52	12.76	21.07
10	9.57	11.36	16.20	11.33	18.10
11	9.16	8.22	14.57	12.36	14.57
12	8.40	10.30	12.92	13.04	13.59
High	14.61	16.75	20.52	14.58	21.07
Low	6.20	6.08	11.35	9.08	12.34

per ton of hulls at Mill 3 in 1959-60 to $21.07 at Mill 9 in 1962-63. In terms of cost of delinting, the spread is around 0.3 to 1.1 cents a pound of linters.

The value of linters left on delinted seed was discussed with mill managers and superintendents. These officials believed that if residual lint left on hulls were increased significantly, a hull marketing problem might arise in some areas. In general, however, the concensus was that with linters left on delinted seed within 1 to 3 percent--the range considered in this study--hull prices would not be affected.

Electric Power

Electric power is one of the most important variable costs in delinting cottonseed. Linter stands use exceptionally large amounts of power. When the lint flue system, lint beaters, gummers, and baling press are considered, overall delinting operations account for one-third to one-half of the total power requirements at most cottonseed mills.

To determine power costs associated with changes in delinting levels, two measurements are needed: (1) Rate at which linter stands use power at various levels of residual linters and, (2) provisions of specific electric rate schedules.

Energy Requirements

Experiments were made to determine kwh consumed by linter stands at varying residual levels. Delinting runs were made on 15 tons of cottonseed having reasonably uniform linters content. The linter stand was a conventional 176-saw machine driven by a 20-horsepower motor. Procedures and results of this study have been reported previously, and only summary information is given here.[4]

The relationship between power consumption, pounds of lint cut, and residual linters left on delinted seed is shown in figure 1. This chart shows that power requirements increase at an increasing rate as closer cuts are made.

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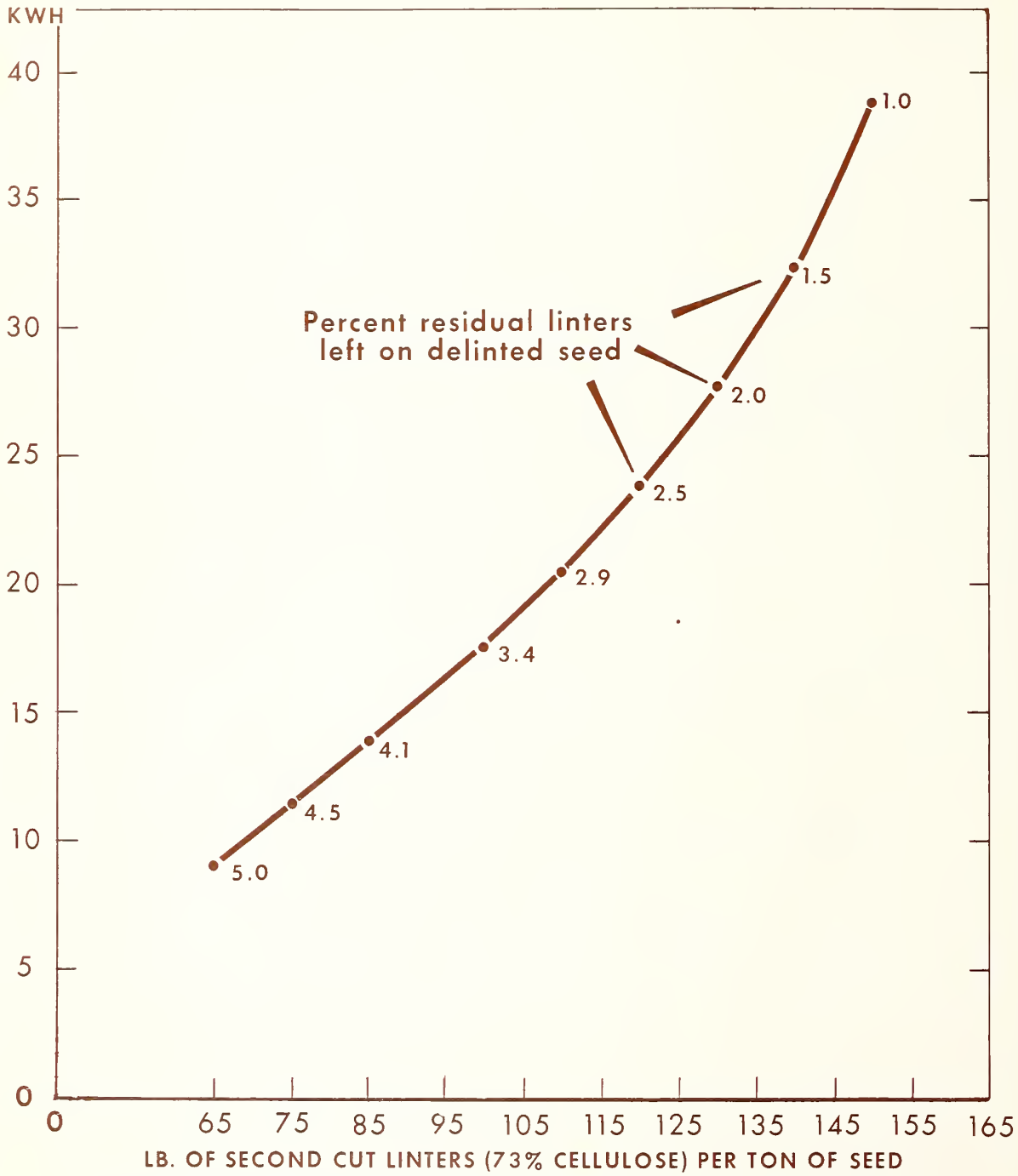
[4] Clark, S. P. Changes in Power Required for Second Cut Delinting with Decreasing Residual Linters on Seed. Cotton Gin and Oil Mill Press, June 9, 1962.

Clark, S. P. Power Requirements for Second Cut Delinting of Cottonseed. Oil Mill Gazetteer, May 1962.

Figure 1. ELECTRIC POWER REQUIRED FOR SECOND-CUT DELINTING AT VARYING LEVELS OF RESIDUAL LINTERS*



* BASED ON EXPERIMENTAL WORK AT COTTONSEED PRODUCTS RESEARCH LABORATORY, COLLEGE STATION, TEX. COTTONSEED USED IN TESTS CONTAINED 7.5% LINTERS AND 8% MOISTURE.

Table 2.--Increases in power requirements with increasing linters cut during second cut delinting, for a single lot of cottonseed containing 7.5 percent linters and 8 percent moisture tested at the Cottonseed Products Research Laboratory, College Station, Tex.

Linters yield (73% cellulose)[1]	Residual linters on delinted seed[2]	Total power requirements per ton of seed	Increase in power requirements for each 5-pound increase in yield of linters
Pounds per ton of cottonseed	Percent	Kwh	Kwh
60		8.1	
65	4.98	9.1	1.0
70		10.2	1.1
75	4.54	11.4	1.2
80		12.6	1.2
85	4.09	13.8	1.2
90		15.0	1.2
95		16.3	1.3
100	3.41	17.6	1.3
105		19.0	1.4
110	2.92	20.5	1.5
115		22.1	1.6
120	2.46	23.8	1.7
125		25.7	1.9
130	1.97	27.7	2.0
135		29.9	2.2
140	1.48	32.3	2.4
145		35.2	2.9
150	0.98	38.9	3.7

[1] Excluding motes.
[2] 8 percent moisture.

Incremental power requirements in units of 5 pounds of linters are shown in table 2. This table was constructed by taking appropriate readings from figure 1.

At the 5-percent residual linters level, power requirements for 5 pounds of linters were 1.0 kwh or 0.2 kwh per pound. At the 1-percent residual linters level, power requirements were 3.7 kwh for 5 pounds of linters or 0.74 kwh per pound. Thus, power requirements to delint a pound of linters at the 1-percent residual linter level were more than 3 times those at the 5-percent level.

The following tabulation taken from figure 1 gives the average kwh consumed between different levels of residual linters:

Residual linters on delinted seed	Power consumption		Linters yield		Average power per pound of linters
Percent	Kwh	Difference	Pounds	Difference	Kwh
3	20		108		
2	27	7	129	21	[1] 0.34
3	20		108		
1	38	18	149	41	[1] 0.45
2	27		129		
1	38	11	149	20	[1] 0.55

[1] Computed from unrounded data.

A delinting change from 3 to 2 percent residual linters required 7.2 kwh for 20.9 pounds of linters, an average 0.34 kwh per pound. A change from 2 to 1 percent residual linters required 11.1 kwh for 20.2 pounds of linters or an average 0.55 kwh per pound.

This information shows that power requirements per pound of linters increase at an increasing rate as lower residual linter levels are reached. The cost of such additional power, however, will depend upon specific rate schedules.

Effect of Rate Schedules

In most electric power rate schedules, power costs are determined by two factors: (1) Billing demand and (2) kilowatt-hour consumption. Demand for a billing period most frequently represents the average kilowatt load in 1 or more 15-minute intervals when the load is greatest during the period. Kilowatt-hour consumption is metered as in common household usage for each billing period. The rate per kwh usually decreases as more kwh are used within the billing period.[5]

Electric rate schedules differ too widely to make specific statements about cost of power to linter stands. However, some general tendencies can be noted.

Demand charges on most power bills are considerably less than kwh charges. In addition, demand charges may or may not be affected by changes in the level of delinting. If some linter stands were shut down completely for the entire billing period, demand would decrease. However, if a decrease in yield of linters is brought about by idling all the linter stands for a given period each day, demand is unchanged.

Changes in delinting level normally affect kwh consumption within lower kwh rate brackets on most schedules. Assume the following schedule:

2.0¢ per kwh, first 1,000 kwh
1.5¢ per kwh, next 4,000 kwh
1.0¢ per kwh, all additional kwh

If the amount of linters cut was reduced and the reductions changed total consumption from 11,000 kwh to 10,000 kwh, the savings in power would be 1,000 kwh at 1.0 cent per kwh, the lowest kwh rate in this schedule.

Table 3 shows the lowest and the second lowest kwh rates in effect at 15 cooperative mills during the 1960-61 season. It also shows length of operating season and the number of months that kwh consumption was great enough to reach into the lowest kwh rate bracket. Mill 2 operated 12 months, and kwh consumption was great enough each month to reach into the lowest kwh bracket. The lowest kwh bracket in table 3 was at Mill 14, but kwh consumption was great enough to reach into the lowest bracket in only 2 months.

The effect of rate schedules on cost of power to linter stands can be shown as follows by applying some of the rates in table 3 to kwh consumption derived from figure 1:

Change in residual linters left on delinted seed	Average kwh per pound of linters	Lowest kwh rate		2nd lowest kwh rate	
		Mill 2 1.00 ¢	Mill 14 0.44 ¢	Mill 2 1.50 ¢	Mill 14 0.60 ¢
	Kwh	Cents per pound of additional linters			
From 3% to 2%	0.34	0.34	0.15	0.51	0.20
From 3% to 1%	.45	.45	.20	.67	.27
From 2% to 1%	.55	.55	.24	.83	.33

[5] Information on how to apply electric rate schedules is given in Campbell, John D. Effects of Electric Rates on Power Expenses of Cotton Gins - Arkansas - Oklahoma - Texas. Mktg. Res. Rpt. 470. Farmer Cooperative Serv., U.S. Dept. Agr. July 1961.

This tabulation shows that cost of power to change from 3 to 2 percent residual linters at the lowest kwh rate is only 0.15 cent per pound of linters at Mill 14 compared with 0.34 cent a pound at Mill 2. Similarly, to change from 2 to 1 percent residual linters at the 2nd lowest rate, the cost per pound of linters at Mill 14 is 0.33 cent compared with 0.83 cent at Mill 2.

Table 3.--Comparison of kwh rates, 15 cooperative cottonseed oil mills, 6 States, 1960-61

Mill No.	Lowest kwh rate	Next-to-lowest kwh rate	Length of operating season	Months operated under lowest kwh rate	Months operated under next-to-lowest kwh rate
	Cents	Cents	Months	Number	Number
1	0.65	0.91	12	11	1
2	[1] 1.00	1.50	12	12	0
3	.50	.80	8	7	1
4	.50	.80	9	7	2
5	.70	1.00	10	10	0
6	.54	.64	10	7	3
7	.60	.80	11	10	1
8	.57	1.00	8	7	1
9	.57	1.00	9	9	0
10	.83	1.08	11	11	0
11	.90	1.20	8	7	1
12	.80	.90	9	8	1
13	.80	.90	9	8	1
14	.44	.60	11	2	9
15	.50	.75	6	6	0

[1] The electric rate schedule of this plant was based on a kwh charge only, without a demand charge. All other plants paid a demand charge in addition to the kwh rate.

Bagging and Ties

Cost of baling linters includes costs associated with the lint flue system, baling press, and wrapping materials (bagging and ties). The most important of these affected by changes in linters cut, however, is the cost of bagging and ties. This cost bears a direct relationship to yield of linters.

Baled linters are sold by oil mills on a gross-weight basis. Therefore, bagging and ties have the same sales value as linters. To obtain the net cost of bagging and ties, it is necessary to deduct the sales value of bagging and ties from their purchase price.

Purchase Price

Purchase prices of bagging and ties vary considerably among mills. The standard bale of linters is covered by 6 yards of bagging and 6 or 8 ties. However, there are differences in kind and weight of bagging. And both bagging and ties can be purchased new or used.

Information from 10 cooperative mills during the 1960-61 season showed bales of linters

ranged from 625 to 650 pounds, including weight of bagging and ties. Ties weighed 1 pound each (8 ties per bale) and bagging ranged from one-half to 1 pound per yard of material (6 yards per bale) for a total bagging and tie weight of from 11 to 14 pounds per bale of linters.

Table 4 shows variation in prices paid for bagging and ties per ton of seed crushed and per 100 pounds of linters produced for 10 cooperative mills. Prices paid ranged from 22.0 cents to 63.0 cents a ton of seed and from 13.7 cents to 29.0 cents per 100 pounds of linters produced.

Table 4.--Purchase prices of bagging and ties at 10 cooperative cottonseed oil mills, 1960-61 [1]

Mill No.	Lint yield per ton of seed crushed	Price of bagging and tie cost per --	
		Ton of seed crushed	100 pounds of linters
	Pounds	Cents	Cents
1	217	63	29.0
2	151	42	27.8
3	161	22	13.7
4	175	40	22.9
5	162	25	15.4
6	167	24	14.4
7	187	43	23.0
8	177	42	23.7
9	184	46	25.0
10	158	38	24.1
Average		38.5	21.9
Highest		63.0	29.0
Lowest		22.0	13.7

[1] Includes all lint, motes, and grabbots.

Bagging per pattern ranged in price from $0.51 to $1.00 and 8 ties from $0.38 to $0.90. Combined price of bagging and ties per pattern ranged from $0.89 to $1.90 and averaged $1.35.

Net Cost

The net cost of bagging and ties is affected significantly by both purchase price and price of linters. The following tabulation compares net cost of bagging and ties under three purchase prices and four linter prices. This tabulation assumes bales of linters weighing 614 pounds (600 pounds of linters and 14 pounds of bagging and ties). Net cost per pound of linters was calculated by deducting the sales values of bagging and ties (14 pounds x price of linters) from purchase price, then dividing the resulting figure by 600.

Purchase price per pattern of bagging & ties	Net cost of bagging and ties per pound of linters when price per pound of linters is:			
	1¢	2¢	3¢	4¢
	Cents			
$0.89	0.13	0.10	0.08	0.06
1.35	0.20	0.18	0.16	0.13
1.90	0.29	0.27	0.25	0.22

The left column shows the lowest, average, and highest prices paid for bagging and ties by 10 cooperative mills during 1960-61. Net cost was the lowest at 0.06 cent per pound of linters where price paid for bagging and ties was $0.89 a pattern and linters sold at 4 cents a pound. The highest net cost was 0.29 cent a pound of linters; it occurred when $1.90 was paid for a pattern of bagging and ties and linters sold at 1 cent a pound.

Operating Labor

Operating labor is one of the more important direct costs of producing linters. Labor in the lint room usually consists of a linter man or lint-room foreman for each shift and--depending on the size of the mill--one or more saw exchangers and helpers. In addition, one or more men are required to operate the baling press.

Baled linters must be stored and loaded for shipment. At smaller-size plants, these functions are frequently performed by the bale-press man and yard labor. However, at larger mills these functions usually require the full time services of one or more men.

Changes in operating labor costs as effected by changes in levels of delinting would be easy to calculate if labor inputs were directly proportional to lint yield, as in the case of bagging and ties. This is not the case, however. A man is not a divisible unit, and the extent that production labor costs change with changes in amount of lint removed depends upon several factors. The main ones are how much lint yield is increased or reduced and whether all men are fully utilized at the time the delinting change is made.

As an example of how operating labor may be affected at one mill and not at another mill, consider the following hypothetical cases:

Item	1% residual linters		3% residual linters	
	Mill A	Mill B	Mill A	Mill B
Daily crush (tons of seed)	100	125	100	125
First-cut linters per ton of seed (lbs.)	50	50	50	50
Second-cut linters per ton of seed (lbs.)	150	150	110	110
Total linters per day (lbs.)	20,000	25,000	16,000	20,000
Linter stands in operation	20	25	16	20
Number of men:				
1st shift	2	2	2	2
2nd shift	1	2	1	1
3rd shift	1	2	1	1

At the 1-percent residual linters level, it takes 1 man to operate 20 linter stands on the second and third shifts at Mill A; but 2 men operate 25 linter stands on the same shifts at Mill B. The men on the second and third shifts at Mill B are not as fully utilized, with 2 men operating 25 linter stands, as the single man at Mill A, who alone operates 20 linter stands.

If changes were made in linter cut from 1-percent to 3-percent residual linters at both mills, total lint cut at Mill A would decrease from 20,000 to 16,000 pounds, and at Mill B from 25,000 to 20,000 pounds. In this case, Mill A would not be able to reduce the number of men for the second and third shifts, since it is already operating with the minimum of one man per shift. But Mill B would be able to decrease the second and third shifts from two men to one man each for a saving of two men per day. For example, if the wage rates of these men were $1.25 per hour, then operating labor costs would be reduced by $20 a day, or 40 cents per 100 pounds of reduced linters.

Linter Saws and Gummer Files

Linter saws and gummer files are among delinting costs most frequently discussed by mill operators. These items are usually purchased once a season and involve a large expenditure at one time. In terms of per unit production cost, however, saw and gummer file costs are relatively minor at most mills.

Table 5 shows a range in saw cost from 0.012 cent to 0.146 cent for each pound of linters produced when blank saws cost 60 cents each.

Table 5.--Comparisons of saw requirements and costs at cottonseed oil mills [1]

Data source	Lint cuts	Lint cut per ton of seed	Lint produced per saw disc worn out	Saws worn out per 100 lb. of lint produced	Saw cost per pound of lint produced at 60¢ per blank saw
		Pounds	Pounds	Number	Cents
Smith [2]	1st & 2nd	220	4,360	.023	.014
Hudson [2]	1st & 2nd	220	4,930	.020	.012
Quinn [2]	3rd	40	1,280	.078	.047
Verdery [2]	1st & 2nd	200	800	.125	.075
	2nd	150	510	.196	.118
	2nd	100	410	.244	.146
Brewster [3]	1st & 2nd	200	890	.112	.067

[1] In some instances, data on saw requirements and costs are primary data supplied by source mentioned. In other instances, it was necessary to derive this information by inference and estimation from published data.

[2] Oil Mill Gazetteer, July 1959.

[3] Brewster, John M. Comparative Economics of Different Types of Cottonseed Oil Mills and Their Effects on Oil Supplies, Prices, and Returns to Growers. Mkt. Res. Rpt. No. 54, U.S. Dept. Agr.

Gummer file costs obtained from three mills and shown in the tabulation below, ranged from 0.017 cent to 0.056 cent a pound of linters produced when files cost 20 cents each.

Lint cuts	Gummers depleted per 100 lbs. of lint	Gummer cost per pound of linters produced at 20 cents per file
	Number	Cents
1 and 2	0.084	0.017
2	.142	.028
1 and 2	.282	.056

Several variables affect saw and gummer file wear. Among the more important factors are variety of seed, condition of seed such as kinds and amounts of foreign material, degree of cleaning before seed goes to linters, and mill operating policies regarding frequency of saw filing and diameter to which saws are worn before replacement.

Changes in delinting levels may or may not affect saw and gummer file cost. This would depend on charges made in frequency of sharpening saws, which in turn depends not only on the dullness of saws, but also upon number of gummers, labor costs, and other considerations.

An estimate of cost of files and gummers affected by changes in delinting level can be obtained from changes made in saw filing schedule. For example, assume a mill is cutting 150 pounds of second-cut lint with an 8-hour saw filing schedule. If this mill reduced its lint cut to 120 pounds, it might be able to change from an 8-hour to a 12-hour filing schedule. In this instance, saws and gummers would last 1 1/2 times as long

as previously. If previous cost averaged 0.1 cent per pound of linters, then average cost would decrease to 0.067 cent a pound. Total saw and gummer cost for 150 pounds would be 15 cents (150 lbs. x 0.1 cent) compared with 8 cents (120 lbs. x 0.067 cent) for the reduced cut to 120 pounds of linters. Therefore, the additional increase of 30 pounds of linters would increase saw and gummer costs by 7 cents, or an average of 0.23 cent per pound.

To obtain estimates of saw and gummer file costs associated with varying delinting levels, it is necessary to know the saw filing schedule at individual mills.

Miscellaneous Costs

In addition to the more important costs already discussed, several smaller costs should also be considered. Among these are maintenance, power to operate delinting machinery other than linter stands, and operating supplies.

Repair labor and parts are perhaps the most important of these miscellaneous costs. Changes in these costs due to changes in levels of delinting would be extremely difficult to measure, however. It is difficult to completely separate maintenance labor from operating labor at most mills, since some maintenance is performed by operating personnel during the crushing season. In addition, wear on parts, just as with saws and gummers, depends upon other factors and will probably not be exactly proportional to changes in linters yield.

Electric power requirements of gummers, filers, lint flue system, lint beaters, and baling press are relatively small compared with requirements to operate linter stands. Moreover, little change in these requirements would be brought about by changes in levels of delinting.

The lint flue system and lint beaters are integral parts of the overall delinting system. Only when a change in delinting level results in the shutting down of the entire lint room for a period of time each day, are kwh power requirements for the lint flue system and lint beaters significantly affected.

Power requirements for gummers and filing machines depend on frequency of saw filing. As was discussed in the section on saws and gummer file costs, filing schedules are based on several considerations and may or may not be changed to meet changes in wear brought about by changes in lint cut.

Changes in lint cut would bring about proportional changes in power for the baling press. Power cost at the baling press is very small, however. A previous study showed power costs of 1 cent and 5 cents to press a bale of cotton to flat and standard densities, respectively.[6] This amounts to only 0.002 cent and 0.01 cent a pound of linters.

Other miscellaneous costs such as belts, brooms, lubrication oil and grease, and gasoline for fork-lift trucks should be mentioned. But these would be minor even when viewed for total linters cut; when based on changes in lint cut, they would be insignificant.

Changes in Revenue from Chemical Linters

Adjustments in levels of delinting not only affect costs but can also affect revenue from chemical linters through changes in yield and quality. By increasing or decreasing the percentage of linters left on delinted seed, linters yield is increased or decreased proportionally. At the same time quality factors may change, especially the amount of hull fiber left in linters. This can affect both the base price and cellulose premium or discount.

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[6] Campbell J. D. and Soxman, R. C. Baling Cotton at Gins, Practices and Costs--Flat, Standard, High Density Bales. Mktg. Res. Rpt. 386, March 1960, p. 24. Farmer Cooperative Serv., U.S. Dept. Agr.

Cleanness and cellulose content of baled linters depend upon several factors such as adequacy of seed cleaning and lint beating efficiency, moisture in seed, and sharpness of linter saws. With a given residual linters level, the more adequate the seed cleaning and lint beating equipment the cleaner the baled lint and the higher the cellulose content and base price.

Since lint beaters are less than 100-percent efficient in removing hull bran from linters going to the bale press, closer delinting cuts result in linters having somewhat lower cellulose content. This can result in a lower price due to cleanness. Cellulose premium would also be adversely affected.

Seed cleaning and lint beater efficiency vary widely among mills as seed condition and operating policies do. Therefore, the effect of changing levels of delinting on quality of chemical linters cannot be measured precisely except perhaps for an individual mill.

Any decrease in price of linters resulting from increased linters cut can be considered a cost of delinting. For example, if an increase in chemical linters production from 120 to 150 pounds a ton of seed results in a price decrease from 2.50 to 2.25 cents a pound, then the cost of producing the additional 30 pounds of linters is 30 cents (120 lbs. x 0.25 cent).

This example assumes the increased amount of linters is blended with second-cut linters, which may not be the case. Some mills may have equipment to handle the additional linters as third-cut linters and bale these separately. If so, the quality and price of second-cut linters would not be affected.

Break-Even Prices of Chemical Linters

Several factors must be considered to get the most profitable return from the delinting operation. The current practice at most mills is to produce both felting linters and chemical linters. Felting linters are usually priced considerably above chemical linters, and a mill's first objective is to get maximum returns from the higher priced product.

After first-cut or felting linters have been delinted, considerable linters remain on seed. Most mill operators consider this amount of linters to be excessive for efficient hulling and further milling and will produce some chemical linters.[7]

Assuming seed has been delinted through the first-cut stage and far enough into the second to facilitate efficient hulling and milling, a decision must be made as to how much closer seed should be delinted to maximize returns to chemical linters.

This decision can be approached by determining the lowest chemical linters price that would induce a mill to change from a given to a lower level of residual linters. For purposes of this report, such a minimum price is referred to as a "break-even price." This price is equal to the cost of delinting to the lower level, including reduction in hull revenue.

As an example, assume that a mill increases its linters cut 20 pounds a ton of seed by going from 3 to 2 percent residual lint on delinted seed. If costs such as power, bagging and ties, etc., were 20 cents and hull price was $20 a ton (1¢ a pound), then the combined cost and reduction in hull revenue would total 40 cents; and the break-even price for chemical linters would be 2 cents a pound. If price of chemical linters is above 2 cents, a delinting change from 3 to 2 percent residual lint

[7] Many oil-mill operators believe that with present machinery no more than from 3 to 4 percent of linters left on seed can be efficiently hulled and milled. However, if prices of chemical linters were to fall to extremely low levels for a long period of time, action might be taken to raise residual level through double hulling or other such means.

on seed would be profitable; if price is less than 2 cents, such a change would not be profitable.

Break-even prices will vary among mills and for different delinting levels at the same mill. Preceding sections of the report discussed variations in specific costs, and illustrative tables showed ranges in costs. This information is summarized in this section for illustrative calculations of break-even chemical linter prices.

Table 6 shows an illustrative calculation of a break-even price for two hypothetical mills. Space is provided for mill operators to insert costs that apply to their individual operations.

Mill A was assigned high costs amd Mill B low costs. Usually a given mill will not be

Table 6.--Illustrative calculations of break-even prices for two hypothetical mills when changing delinting cut from 3% to 1% residual linters left on seed

Item	Unit	Mill A			Mill B			Your mill		
		Unit price	Units per 100 lbs. of lint	Cost per 100 lbs. of lint	Unit price	Units per 100 lbs. of lint	Cost per 100 lbs. of lint	Unit price	Units per 100 lbs. of lint	Cost per 100 lbs. of lint
				Cents			Cents			Cents
Hulls (reduction in hull revenue)	Ton	$25.00	100 lbs.	125.0	$10.00	100 lbs.	50.0	____	____	____
Power to linter stands	Kwh	1.5¢	45 kwh	67.5	0.44¢	45 kwh	19.8	____	45 kwh	____
Bagging & ties [1]	Pattern	$1.48	.167	24.7	$0.56	.167	9.3	____	____	____
Operating labor [2]	Man-hour	$1.25	.32	40.0		No change	0	____	____	____
Linter saws [3]	Saw disc	$0.60	.1	6.0		No change	0	____	____	____
Gummer files [3]	Gummer file	$0.20	.3	6.0		No change	0	____	____	____
Maintenance [4]	-	-		-			-	____	____	____
Other [5]	-	-		-			-	____	____	____
Total				269.0			79.1			
Break-even price per pound of chemical linters [6]				2.7¢			0.8¢			____

[1] Unit price of bagging and ties is purchase price less value of bagging and ties (weight of bagging and ties multiplied by price of linters). Purchase price at Mill A assumed to be $1.90 less 14 lbs. at 3¢ linter price. Purchase price at Mill B assumed to be $0.89 less 11 lbs. at 3¢ linter price.

[2] For illustrative purposes, Mill B can increase linter production without any change in operating labor; whereas Mill A must add 1 man to the second and third shifts. Assuming 5,000 lbs. increased linter yield, cost per 100 lbs. of increased linters is $40¢ \left(\frac{16 \text{ man-hours} \times \$1.25 \text{ per hour}}{5{,}000 \text{ lbs. of linters}}\right)$.

[3] It is assumed that Mill B does not change saw filing schedule; therefore, it would have no change in wear on saws or gummer files.

[4] Changes in maintenance and other costs could not be estimated from available data.

[5] Includes power for baling press, lube oil and grease, and other miscellaneous items.

[6] Break-even price obtained by dividing cost for 100 pounds of linters by 100.

high or low on all cost items. But this arrangement shows the full effect of variation in costs on break-even prices.

Information in table 6 is based on changing linter cut from 3 to 1 percent residual linters left on delinted seed. As mentioned earlier, such costs as bagging and ties are proportional regardless of delinting level; whereas other costs, such as power, change with delinting level. To show tables for each range of delinting levels would be repetitive. Rather, it is assumed that when a mill operator obtains a break-even price for one level of delinting, he will make cost adjustments when considering other delinting levels.

All costs are not included in table 6. For example, maintenance and other miscellaneous costs are not included because they could not be estimated from available data. Furthermore, information in this table assumes no reduction in the price of chemical linters.

Mill B could profitably change from 3 to 1 percent residual linter level with a chemical linter price as low as 0.8 cent a pound. Mill A, however, must receive 2.7 cents a pound to make the same delinting change.

Reduction in hull revenue can be by far the most important single cost of delinting. When hull price is $25 a ton, as in the case of Mill A, 1.25 cents a pound of additional linters is added to delinting costs. This is almost one-half the break-even linter price for Mill A, and considerably more than the total break-even price at Mill B. Even at a relatively low hull price of $10 a ton, as in the case at Mill B, reduction in hull revenue is 0.5 cent a pound of additional linters. This is greater than any other cost at either mill except for power at Mill A.

Next to reduction in hull revenue, the most important costs are power for linter stands and operating labor, if affected. Cost of power at Mill A was 0.68 cent a pound of linters compared with only 0.20 cent at Mill B, which has a low electrical rate schedule. Cost of power would differ for other delinting levels and can be relatively important or unimportant, depending mostly upon rate schedules and to a lesser extent upon the delinting level.

Operating labor, if affected at all by changes in delinting level, can be an important cost. At Mill A, labor was assumed to be fully utilized and the increase in linter production required an additional man for each of two shifts a day, or an increase of 16 man-hours a day. The increased linters production was assumed to be 5,000 pounds (125 tons of seed per day x 40 pounds per ton additional linters). At a wage rate of $1.25 an hour, increased operating labor would cost 0.4 cent a pound of additional linters.

Bagging and tie costs depend upon purchase price, weight of bagging, and linters price. In the illustration, Mill A paid $1.90 per pattern weighing 14 pounds. When linter price is 3 cents a pound, the net cost is $1.48, or 0.25 cent a pound of linters. Mill B paid only $0.89 for 11 pounds of used light-weight bagging, and used ties. At a 3-cent linter price, net cost was $0.56 a pattern, or only 0.09 cent a pound of linters.

Cost of linter saws and gummer files is relatively insignificant. At Mill A the cost for each of these was 0.06 cent a pound of additional linters, although Mill A had high saw and gummer file consumption.

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Several costs are involved in recovery of chemical linters, but some of these are minor. For practical purposes, mill management can use the techniques explained in this report to approximate break-even chemical linter prices by determining these important cost items: Reduction in hull revenue, cost of power to linter stands, operating labor if affected, and net cost of bagging and ties.

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